

Disturbance of Eelgrass (*Zostera marina* L.) by Commercial Mussel (*Mytilus edulis*) Harvesting in Maine: Dragging Impacts and Habitat Recovery

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PROBLEM

- Eelgrass (*Zostera marina* L.) forms the basis of highly productive coastal ecosystems on the Atlantic coast
- Mobile fishing gear is a threat to eelgrass habitat
- Establishment of regulations to protect eelgrass from dragging activity is hampered by lack of information on gear impacts and habitat recovery-times following dragging

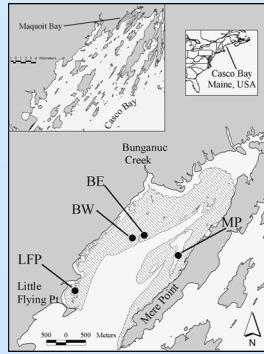


In Maine, mussels may occur adjacent to and interspersed with eelgrass (top left). When mechanical drags are towed through eelgrass beds to harvest mussels, eelgrass is pulled up as well (left), leaving areas that appear denuded on aerial photographs (above, in Maquoit Bay, Maine).



APPROACH

- We used a time series of aerial photographs to identify sites that had been disturbed by dragging at different times in the past decade
- During 2000 and 2001, we used aerial photography and eelgrass population- and shoot-based measurements to quantify effects of historic and recent disturbance
- Measurements were analyzed at a hierarchy of scales to document and project recovery rates



Study sites in Maquoit Bay, Maine.
Stippled area is eelgrass cover in 2000.

EFFECTS OF DRAGGING

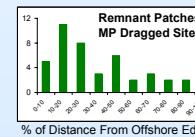
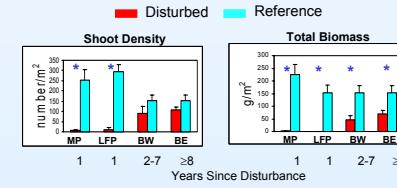
BAYWIDE IMPACTS

- In 2000 there were 535.5 ha of eelgrass in Maquoit Bay.
- 10% of the total eelgrass cover showed evidence of dragging disturbance during the previous decade.

Dragging Sites	Area of Impact (ha)
BE	8.4
BW	9.6
LFP	3.4
MP	31.8
TOTAL	53.2

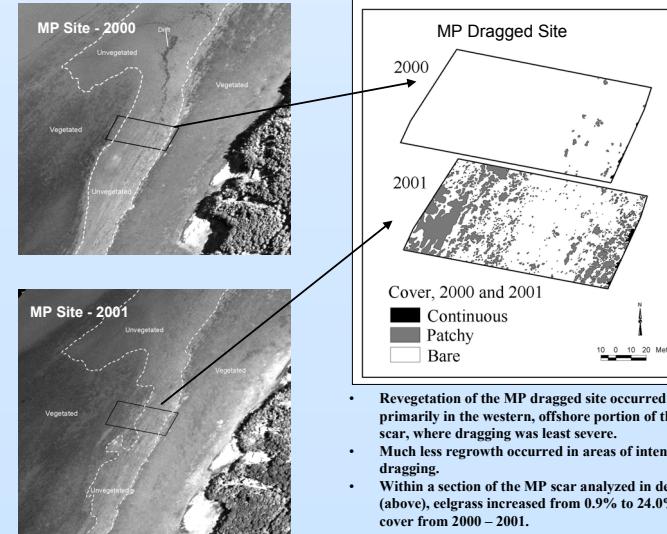
WITHIN-BED IMPACTS

- One year after dragging, eelgrass shoot density, canopy height, and total biomass were dramatically lower in sites disturbed by dragging than in adjacent reference beds one year after dragging.
- Differences in eelgrass biomass persisted up to 7 years post-dragging.
- Dragging did not affect physical characteristics of the sediment.



Underwater video transects (n=3) of the MP dragged site showed that remnant patches of mature plants covered a mean of 14% of the transect length 1 year post-dragging.

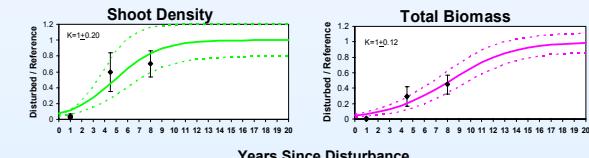
LARGE-SCALE PATTERNS OF EELGRASS RECOVERY



PROJECTED RECOVERY RATE

SUBSTITUTION OF SPACE FOR TIME

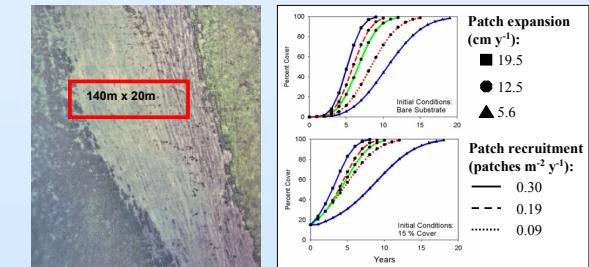
- Percent recovery defined as the ratio of mean eelgrass measurement (density or biomass) in a disturbed site to the mean measurement in the adjacent reference site.
- Logistic growth equation used to relate percent recovery to time since disturbance.
- Best-fit mean trajectories yielded estimates of **10.6 years** for 95% recovery of shoot density and **16.3 years** for 95% recovery of total biomass.



SPATIAL SIMULATION MODEL

- Model projections were based on field measurements of the rate of new patch recruitment into dragged areas and the rate of lateral patch expansion
- Recovery was defined as simulated revegetation to 95% cover

Conditions for Model Simulation



- Dragged area with two vegetated boundaries
- Mean patch recruitment rate = **0.19 m⁻² y⁻¹**
- Mean patch expansion rate = **12.5 cm y⁻¹**
- Remnant patches, if present, distributed as 1-m² patches
- Model simulated under a realistic range of recruitment and expansion rates
- Predicted mean recovery time (green trajectory) for an area dragged to 0% cover was **11 years**
- Predicted mean recovery time for an area with 15% cover post-dragging was **9 years**
- Under conditions less conducive to eelgrass growth (lower recruitment and expansion rates), recovery could take up to **22 years**

CONCLUSIONS

- Mussel dragging poses a threat to eelgrass habitat
- Impact and recovery time depend on dragging intensity
- Effects of intensive dragging are severe and long-lasting
- Under conditions conducive to eelgrass growth, revegetation expected to take 9–11 years
- Full, functional recovery expected to take longer
- Revegetation may take 20 years or longer under conditions less suitable for growth